

Part II

4

Getting Organized and Identifying Problems and Opportunities

4.A Getting Organized

4.B Problem and Opportunity Identification

The impetus for a restoration initiative may come from several sources. The realization that a problem or opportunity exists in a stream corridor may warrant community action and any number of interested groups and individuals may be actively involved in recognizing the situation and initiating the restoration effort. Federal or state agencies may be designated to undertake a corridor restoration effort as a result of a legislative mandate or an internal agency directive. Citizen groups or groups with special cultural or economic interests in the corridor (e.g., native tribes, sport fishermen) may also initiate a restoration effort. Still others might undertake stream corridor restoration as part of a broad-based cooperative initiative that draws from various funding sources and addresses a diversity of interests and objectives.

Accompanying the recognition of the situation and initiation of the restoration effort is the initial proposal of “the solution.” This almost instantaneous leap from problem/opportunity recognition to the identification of the initial

“solution” occurs during the formative stage of nearly every initiative involving water and multiple landowners. This instantaneous leap might not always address the true causes of the problem or identified opportunity and therefore might not result in a successful restoration initiative. Projects that come through a logical process of plan development tend to be more successful.

Regardless of the origins of the restoration initiative or the introduction of the proposed “solution,” it is essential that the focus of the leadership for the restoration planning process be at the local level; i.e., the people who are pushing for action, who own the land, who are affected, who might benefit, who can make decisions, or who can lead. With this local leadership in place, a logical, iterative restoration plan development process can be undertaken. Often, this approach will involve going back to the identification of the problem or opportunity and realizing that the situation is not as simple as initially perceived and needs further definition and refinement.

This chapter concentrates on the two initial steps of stream corridor restoration plan development—getting organized and problem/opportunity identification. The chapter is divided into two sections and includes a discussion of the core components of each of these initial steps.

Section 4.A: Getting Organized

This section outlines some of the organizational considerations that should be taken into account when conducting stream corridor restoration.

Section 4.B: Problem and Opportunity Identification

Once some of the organizational logistics have been settled, the disturbances affecting the stream corridor ecosystem and the resulting problems/opportunities need to be identified. Section B outlines the core components of the problem/opportunity identification process. One of the most common mistakes made in planning restorations is the failure to characterize the nature of the problems to be solved and when, where, and exactly how they affect the stream corridor.

4.A Getting Organized

This section presents the key components of organizing and initiating the development of a stream corridor restoration plan and establishing a planning and management framework to facilitate communication among all involved and interested parties. Ensuring the involvement of all partners and beginning to secure their commitment to the project is a central aspect of “getting organized” and undertaking a restoration initiative. (See Chapter 6 for detailed information on securing commitments.) It is often helpful to identify a common motivation for taking action and also to develop a rough outline of restoration goals. In addition, defining the scale of the corridor restoration initiative is important. Often the issues to be addressed require that restoration be considered on a watershed or whole-reach basis, rather than by an individual jurisdiction or one or two landholders.

Setting Boundaries

Geographical boundaries provide a spatial context for technical assessment and a sense of place for organizing community-based involvement. An established set of project boundaries streamlines the process of gathering, organizing, and depicting information for decision making.

When boundaries are selected, the area should reflect relevant ecological processes. The boundaries may also reflect the various scales at which ecological processes influence stream corridors (see Chapter 5, *Identifying*

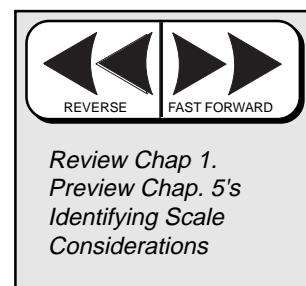
Core Components of Getting Organized

- Setting boundaries
- Forming an advisory group
- Establishing technical teams
- Identifying funding sources
- Establishing points of contact and a decision structure
- Facilitating involvement and information sharing among participants
- Documenting the process

Scale Considerations). For example, matters affecting the conservation of biodiversity tend to play out at broader, more regional scales. On the other hand, the quality of drinking water is usually more of a basin-specific or local-scale issue.

In setting boundaries, two other factors are equally as important. One is the nature of human-induced disturbance, including the magnitude of its impact on stream corridors. The other factor is the social organization of people, including where opportunities for action are distributed across the landscape.

The challenge of establishing useful boundaries is met by conceptually superimposing the three selection factors. One effective way of starting this process is through the identification, by public forum or other free and open means, of a stream reach or aquatic resource area that is particularly valued by the community. The scoping process would continue by having resource managers or landown-



Forming an advisory group is an effective and efficient way to plan and manage the restoration effort, although not all restoration decision makers will choose to establish one.

ers define the geographical area that contributes to both the function and condition of the valued site or sites. Those boundaries would then be further adjusted to reflect community interests and goals.

Forming an Advisory Group

Central to the development of a stream corridor restoration plan is the formation of an *advisory group* (**Figure 4.1**). An advisory group is defined as a collection of key participants, including private citizens, public interest groups, economic interests, public officials, and any other groups or individuals who are interested in or might be affected by the restoration initiative. Grassroots citizen groups comprise multiple interests that hopefully share a stated common concern for environmental conservation. Such broad-based participation helps ensure that self-interest or agency agendas do not drive the process from the top down. Local citizens should be enlisted and informed to the extent that their values and preferences drive decision-making with technical guid-

ance from agency participants.

The advisory group generally meets for the following purposes:

- Carrying out restoration planning activities.
- Coordinating plan implementation.
- Identifying the public's interest in the restoration effort.
- Making diverse viewpoints and objectives known to decision makers.
- Ensuring that local values are taken into account during the restoration process.

The point to remember is that the true role of the advisory group is to advise the *decision maker* or *sponsor*—the agency(s), organization(s), or individual(s) leading and initiating the restoration effort—on the development of the restoration plan and execution of restoration activities. Although the advisory group will play an active planning and coordinating role, it will not make the final decisions. As a result, it is important that all members of the advisory group understand the issues, develop practical and well thought-out recommendations, and achieve consensus in support of their recommendations.

Typically, it is the responsibility of the decision maker(s) to identify and organize the members of the advisory group. Critical to this process is the identification of the key participants. Participants can be identified by making announcements to the news media, writing to interested organizations, making public appearances, or directly contacting potential partners.

Figure 4.1: Advisory group meeting.

The advisory group, composed of a variety of community interests, plays an active role in advising the decision maker(s) throughout the restoration process.

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Lower Missouri River Coordinated Resource Management Efforts in Northeast Montana

The Lower Missouri River Coordinated Resource Management (CRM) Council is an outgrowth of the Lower Fort Peck Missouri River Development Group, which was formed in September 1990 as a result of an irrigation and rural development meeting held in Poplar, Montana. The meeting was held to determine the degree of interest in economic and irrigation development along the Missouri River below Fort Peck Dam.

A major blockade to development seemed to be the erosion problems along the river. The Roosevelt County Conservation District and other local leaders decided that before developing irrigation along the river, streambank erosion needed to be addressed.

The large fluctuation of the water being released from Missouri River dams is causing changes in the downstream river dynamics, channel, and streambanks. Before the dams, the river carried a sediment load based on the time of the year and flow event. Under natural conditions, a river system matures and tries to be in equilibrium by transporting and depositing sediment. Today, below the dams, the water is much cleaner because the sediment has settled behind the dams (**Figure 4.2**). The clean water releases have changed the river system from what it was prior to the dams. The clean water now picks up sediment in the river and attacks the streambanks, while trying to reach equilibrium. These probable causes and a river system out of equilibrium could be part of the cause of the river erosion.



Figure 4.2: Lower Missouri River.

Water released from dams is causing downstream erosion.

Leaders in the group are politically active, traveling to Washington, D.C., and meeting with congressional delegates and the US Army Corps of Engineers (USACE) to secure funding to address streambank erosion. As a result of the trips to Washington, \$3 million was appropriated and transferred to the USACE for streambank erosion abatement. However, efforts to agree on a mutually beneficial solution continued to delay the progress. The USACE had completed an economic analysis of the area, and the only viable alternative it could offer was sloughing easements. This would do little to save the valuable soils along the Missouri River.

The group seemed to be at a stalemate. In July 1994, then Chief of the Natural Resources Conservation Service (NRCS), Paul Johnson, met with the members of the Lower Fort Peck Missouri River Development Group, local landowners, surrounding Conservation District members, NRCS field office staff, and Bill Miller, Project Manager for the Omaha District of the USACE, at an erosion site along the Missouri River. After sharing of ideas and information, Chief Johnson suggested that a Coordinated Resource Management (CRM) group be formed to resolve the sensitive issues surrounding the erosion and other problems of the river. He instructed local and state NRCS staff to provide technical assistance to the CRM group. The group followed Chief Johnson's idea, and the Lower Missouri River CRM Council was formed. This has helped those involved in solving the problems to overcome many of the stumbling blocks with which they were being confronted. Some of these successes include:

- Through the CRM Council the \$3 million transferred to the USACE was used to try some new innovative erosion solutions on a site in Montana and one in North Dakota. The group helped the USACE to select the site. NRCS assisted in the design and implementation. For the first time in this area, materials such as hay bales, willow cuttings, and log revetments were used.
- An interagency meeting and tour of erosion sites was sponsored by the CRM Council in September of 1996. In addition to local producers, CRM Council members, NRCS state and national staff, USACE staff, researchers from the USDA Agricultural Research Service (ARS) National Sedimentation Laboratory of Oxford, Mississippi, attended the session. The group agreed that the erosion problem needed to be studied further. The NRCS, USACE, and ARS have been doing studies on the River System below Fort Peck Dam since the 1996 meeting. A final report on the research is planned for summer of 1998.
- The CRM Council has been surveying producers along the river to determine what they perceive to be their major problems. This helps the group to stay in tune with current problems.
- The CRM Council contracted with a group of Montana State University senior students from the Film and TV Curriculum to develop an informational video about the Missouri River and its resources. This project has been completed, and the video will be used to show legislators and others what the problems and resources along the river are.

The group has been successful because of the CRM process. The process takes much effort by all involved, but it does work.

Watershed Planning Through a Coordinated Resource Management Planning Process

The American River watershed, located in the Sierra Nevada Mountains of California, comprises 963 square miles. It is an important source of water for the region. The watershed also supports a diversity of habitats from grassland at lower elevations, transitioning to chaparral and to hardwood forest, and eventually to coniferous forest at upper elevations. In addition, the watershed is a recreational and tourist destination for the adjacent foothill communities like the greater Sacramento metropolitan area and the San Francisco Bay area.

Urban development is rapidly expanding in the watershed, particularly at lower elevations. This additional development is challenging environmental managers in the watershed and stressing the natural resources of the area. In 1996, the Placer County Resource Conservation District (PCRC) spearheaded a multi-interest effort to address watershed concerns within the American River watershed. Due to the range of issues to be addressed, they sought to involve representatives from various municipalities, environmental and recreational groups, fire districts, ranchers, and state and federal agencies. The group established a broad goal “to enhance forest health and the overall condition of the watershed,” as well as a set of specific goals that include the following:

- Actively involve the community and be responsive to its needs.
- Optimize citizen initiative to manage fuels on private property to enhance forest and watershed.
- Restore hydrologic and vegetative characteristics of altered meadows and riparian areas.
- Create and sustain diverse habitats supporting diverse species.
- Ensure adequate ground cover to prevent siltation of waterways.
- Reduce erosion from roads and improvements.
- Prevent and correct pollution discharges before they adversely affect water quality.
- Reduce excessive growths of fire-dependent brush species.
- Increase water retention and water yield of the watershed.
- Optimize and sustain native freshwater species.

Because of past conflicts and competing interests among members of the group, a Memorandum of Understanding (MOU) was prepared to develop a cooperative framework within which the various experts and interest groups could participate in natural resource management of the watershed. The signatories jointly committed to find common ground from which to work. The first step was to establish “future desired conditions” that will meet the needs of all the signatories as well as the local landowners and the public.

By including all of the signatories in the prioritization of implementation actions, PCRC continues to keep the watershed planning process moving forward. In addition, PCRC has encouraged the development of a small core group of landowners, agency representatives, and environmental organizations to determine how specific actions will be implemented. Several projects that incorporate holistic ecosystem management and land stewardship principles to achieve measurable improvements within the watershed are already under way.

The exact number of groups or individuals that will compose the advisory group is difficult to determine and is usually situation-specific. In general, it is important that the group not be so small that it is not representative of all interests. Exclusion of certain community interests can undermine the legitimacy of or even halt the restoration initiative. Conversely, a large group might include so many interests that organization and consensus building become unmanageable. Include a balance of representative interests such as the following:

- Private citizens
- Public interest groups
- Public officials
- Economic interests

It is important to note that while forming an advisory group is an effective and efficient way to plan and manage the restoration effort, not all restoration decision makers will choose to establish one. There might be cases where a landowner or small group of landowners elect to take on all of the responsibilities of the advisory group in addition to playing a leadership or decision-making role.

Regardless of the number of individuals involved, it is important for all project participants (and funders) to note at this early stage that the usual duration of projects is 2 to 3 years. There are no guarantees that every project will be a success, and in some cases a project may fail simply due to lack of time to allow nature to "heal itself" and restoration methods to take effect. All participants must be reminded up front to set realistic expectations for the project and for themselves.

Establishing Technical Teams

Planning and implementing restoration work requires a high level of knowledge, skill, and ability, as well as professional judgment. Often, the advisory group will find it necessary to establish special technical teams, or subcommittees, to provide more information on a particular issue or subject.

In general, interdisciplinary technical teams should be organized to draw upon the knowledge and skills of different agencies, organizations, and individuals. These teams can provide continuity as well as important information and insight from varied disciplines, experiences, and backgrounds.

The expertise of an experienced multidisciplinary team is essential. No single text, manual, or training course can provide the technical background and judgment needed to plan, design, and implement stream corridor restoration. A team with a broad technical background is needed and should include expertise in both engineering and biological disciplines, particularly in aquatic and terrestrial ecology, hydrology, hydraulics, geomorphology, and sediment transport.

Team members should represent interagency, public, and private interests and include major partners, especially if they are sharing costs or work on the restoration initiative. Team makeup is based on the type of task the team is assembled to undertake. Members of the technical teams can also be members of the advisory committee or even the decision-making body.

Some of the technical teams that could be formed to assist in the restoration initiative will have responsibilities such as these:

- Soliciting financial support for the restoration work.
- Coordinating public outreach.
- Providing scientific support for the restoration work. This support may encompass anything from conducting the baseline condition analysis to designing and implementing restoration measures and monitoring.
- Investigating sensitive legal, economic, or cultural issues that might influence the restoration effort.
- Facilitating the restoration planning, design, and implementation process outlined in this document.

It is important to note that technical expertise often plays an important role in the success of restoration work. For example, a restoration initiative might involve resource management or land

use considerations that are controversial or involve complex cultural and social issues. An initiative might address issues like western grazing practices or water rights and require the restriction of certain activities, such as timber or mineral extraction, certain farming and grazing practices, or recreation (**Figure 4.3**). In these cases, involving persons who have the appropriate expertise on regulatory programs, as well as social, political, and legal issues, can prevent derailment of the restoration effort.

Perhaps the most important benefit of establishing technical teams, however, is that the advisory group and decision makers will have the necessary information to develop restoration objectives. The advisory group will be able to integrate the knowledge gained from the analysis of what is affecting stream corridor structure and functions with the information on the social, political, and economic factors operative within the stream corridor. Essentially, the advisory group will be able to help define a thorough set of restoration objectives.

Interdisciplinary Nature of Stream Corridor Restoration

The complex nature of stream corridor restoration requires that any restoration initiative be approached from an interdisciplinary perspective. Specialists from a variety of disciplines are needed to provide both the advisory group and sponsor with valuable insight on scientific, social, political, and economic issues that might affect the restoration effort. The following is a list of some of the professionals who can provide important input for this interdisciplinary effort:

- | | | |
|------------------------|--------------------------------|---------------------------------------|
| • Foresters | • Legal consultants | • Botanists |
| • Microbiologists | • Engineers | • Hydrologists |
| • Economists | • Geomorphologists | • Archaeologists |
| • Sociologists | • Soil scientists | • Rangeland specialists |
| • Landscape architects | • Fish and wildlife biologists | • Public involvement specialists |
| • Real estate experts | • Ecologists | • Native Americans and Tribal Leaders |



Figure 4.3: Livestock grazing.
Technical teams can be helpful in addressing controversial and complex issues that have the potential to influence the acceptance and success of a restoration initiative.

Identifying Funding Sources

Identifying funding sources is often an early and vital step toward an effective stream restoration initiative. The funding needed may be minimal or substantial, and it may come from a variety of sources. Funding may come from state or federal sources that have recognized the need for restoration due to the efforts of local citizens' groups. Funding may come from counties or

any entity that has taxing authority. Philanthropic organizations, nongovernmental organizations, landowners' associations, and voluntary contributions are other funding sources. Regardless of the source of funds, the funding agent (sponsor) will almost certainly influence restoration decisions or act as the leader and decision maker in the restoration effort.

Establishing a Decision Structure and Points of Contact

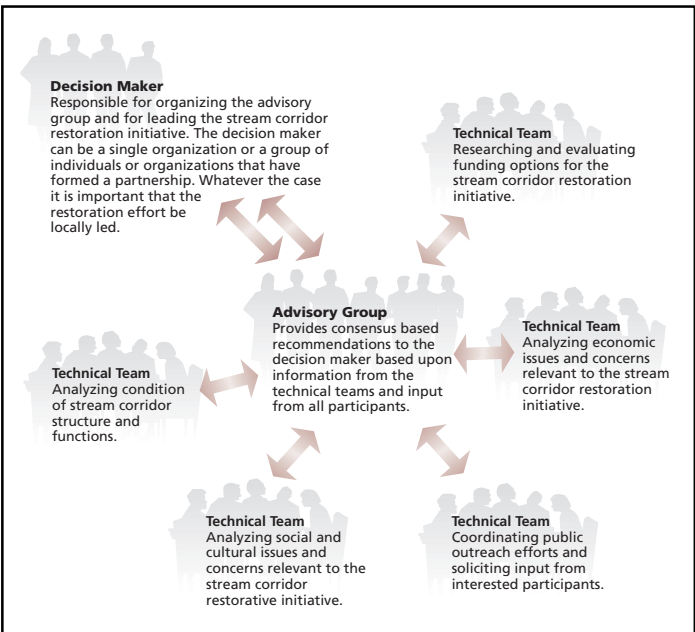
Once the advisory group and relevant technical teams have been formed, it is important to develop a decision-making structure (**Figure 4.4**) and to establish clear points of contact.

As noted earlier, the advisory group will play an active planning and coordinating role, but it will not make the final decisions. The primary decision-making authority should reside in the hands of the stakeholders. The advisory group, however, will

play a strong role by providing recommendations and informing the decision maker(s) of various restoration options and the opinions of the various participants.

It is important to note that the decision maker, as well as the advisory group, may be composed of a collection of interests and organizations. Consequently, both entities should establish some basic protocols to facilitate

Figure 4.4: Flow of communication.
Restoration plan development requires a decision structure that streamlines communication between the decision maker, the advisory group, and the various technical teams.



decision making and communication. Within each group some of the following rules of thumb might be helpful:

- Select officers
- Establish ground rules
- Establish a planning budget
- Appoint technical teams

In conjunction with establishing a decision structure, the sponsor, advisory group, and relevant subcommittees need to establish points of contact. These points of contact should be people who are accessible and possess strong outreach and communication skills. Points of contact play an important role in the restoration process by facilitating communication among the various groups and partners.

Facilitating Involvement and Information Sharing Among Participants

It is important that every effort be made to include all interested parties throughout the duration of the restoration process. Solicit input from participants and keep all interested parties informed of the plan development, including uncertainties associated with a particular solution, approach, or management prescription and what must be involved in modifying and adapting them as the need arises. In other words, it is important to operate under the principles of both information giving and information receiving.

Receiving Input from Restoration Participants

In terms of information receiving, a special effort should be made to directly contact landowners, resource users, and other interested parties to ask them to participate in the planning process. Typically, these groups or individuals will have some personal interest in the condition of the stream corridor and associated ecosystems in their region. A failure to provide them the opportunity to review and comment on stream corridor restoration plans will often result in objections later in the process.

Private landowners, in particular, often have the greatest personal stake in the restoration work. As part of the restoration effort it might be necessary for private landowners to place some of their assets at increased risk, make them more available for public use, or reduce the economic return they provide (e.g., restricting grazing in riparian areas or increasing buffer widths between agricultural fields and drainage channels). Thus, it is in the best interest of the restoration initiative to include these persons as decision makers.

A variety of public outreach tools can be useful in soliciting input from participants. Some of the most common mechanisms include public meetings, workshops, and surveys.

Tools for Facilitating Participant Involvement and Information Sharing During the Restoration Process, provides a more complete list of potential outreach options.

Informing Participants Throughout the Restoration Process

In addition to actively seeking input from participants, it is important that the sponsor(s) and the advisory group regularly inform the public of the status of the restoration effort. The restoration initiative can also be viewed as a strong educational resource for the entire community. Some effective ways to communicate this information and to provide educational opportunities include newsletters, fact sheets, seminars, and brochures. A more complete list of potential outreach tools is provided in the box *Tools for Facilitating Participant Involvement and Information Sharing During the Restoration Process*.

It is important to note that the educational opportunities associated with information giving can help support restoration initiatives. For example, in cases that require the implementation of costly management prescriptions,

outreach tools can be effective in improving landowner awareness of ways in which risks and losses can be offset, such as incentive programs (e.g., Conservation Reserve Program) or cost-sharing projects (e.g., Section 319 of the Clean Water Act). In these cases, the most effective approach might be for the representative landowners serving on the decision-making team to be responsible for conducting this outreach to their constituents.

In addition, educational outreach can also be viewed as an opportunity to demonstrate the anticipated benefits of restoration work, on both regional and local levels. One of the most effective ways to accomplish this is with periodic public field days involving visits to the restoration corridor, as well as pilot demonstration sites, model farms, and similar examples of restoration actions planned.

Finally, wherever possible, information on the effectiveness and lessons learned from restoration work should be made available to persons interested in carrying out restoration work elsewhere. Most large restoration initiatives will require relatively detailed documentation of design and performance, but this information is usually not widely distributed. Summaries of restoration experiences can be published in any of a variety of technical journals, newsletters, bulletins, Internet Web sites, or other media and can be valuable to the success of future restoration initiatives.

Tools for Facilitating Participant Involvement and Information Sharing During the Restoration Process

Tools for Receiving Input

- Public Hearings
- Task Forces
- Training Seminars
- Surveys
- Focus Groups
- Workshops
- Interviews
- Review Groups
- Referendums
- Phone-in Radio Programs
- Internet Web Sites

Tools for Informing Participants

- Public Meetings
- Internet Web Sites
- Fact Sheets
- News Releases
- Newsletters
- Brochures
- Radio or TV Programs or Announcements
- Telephone Hotlines
- Report Summaries
- *Federal Register*

Selecting Tools for Facilitating Information Sharing and Participant Involvement

Although a variety of outreach tools can be used to inform participants and solicit input, attention should be paid to selecting the best tool at the most appropriate time. In making this selection, it is helpful to consider the stage of the restoration process as well as the outreach objectives.

For example, if a restoration initiative is in the early planning stages, providing community members with background information through a newsletter or news release might be effective in bringing interested parties to the table and in generating support for the initiative (**Figures 4.5 and 4.6**). Conversely, once the planning process is well under way and restoration alternatives are being selected, a public hearing may be a useful mechanism for receiving input on the desirability of the various options under consideration (**Figure 4.7**).

Some additional factors that should be taken into account in selecting outreach tools include the following:

- Strengths and weaknesses of individual techniques.
- Cost, time, and personnel required for implementation.
- Receptivity of the community.

Again, no matter what tools are selected, it is important to make an effort to solicit input from participants as well as to keep all interested parties informed of plan developments. The Interagency Ecosystem Management Task Force (1995) provides the following suggestion for a combination of techniques that can be used to facilitate participant involvement and information sharing:



Figure 4.5: Chesapeake Bay Foundation newsletter.

Newsletters can be an effective way to communicate the status of restoration efforts to the community.

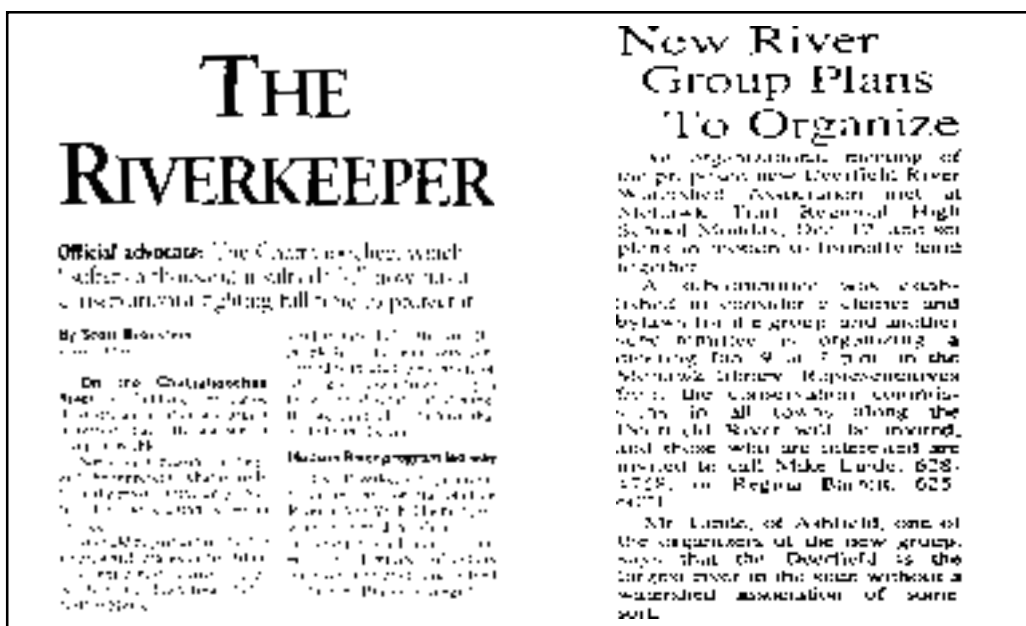


Figure 4.6: Regional restoration news releases.

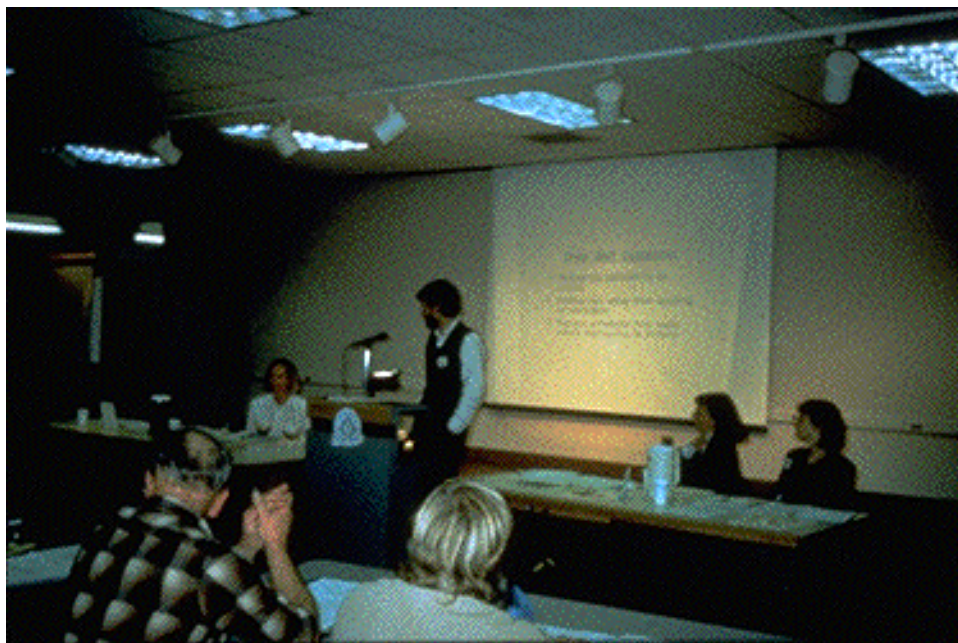
A news release is an effective tool for informing the community of the planning of the restoration initiative.

Source: River Networks, 1995

Figure 4.7: Local public hearing.

Public hearings are a good way to solicit public input on restoration options.

Source: S. Ratcliffe.
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- Regular newsletters or information sheets apprising people of plans and progress.
- Regularly scheduled meetings of landowner and citizen groups.
- Public hearings.
- Field trips and workdays on project sites for volunteers and interested parties.

In addition, the innovative communication possibilities afforded by the Internet and the World Wide Web cannot be ignored.

Documenting the Process

The final element of getting organized involves the documentation of the various activities being undertaken as part of the stream corridor restoration effort. Although the restoration plan, when completed, will ultimately document the results of the restoration process, it is also important to keep track of activities as they occur.

An effective way to identify important restoration issues and activities as well as keep track of those activities is through the use of a “restoration checklist” (National Research Council, 1992). The checklist can be maintained by the advisory group or sponsor and used to engage project stakeholders and to inform them of the progress of restoration efforts. The checklist can serve as an effective guide through the remaining components of restoration plan development and project implementation. In addition, a draft version of *Developing a Monitoring Plan* (see Chapter 6) should be prepared as part of planning data collection.



Restoration Checklist (Adapted from National Research Council 1992)**During Planning...**

- Have all potential participants been informed of the restoration initiative?
- Has an advisory committee been established?
- Have funding sources been identified?
- Has a decision structure been developed and points of contact identified?
- Have steps been taken to ensure that participants are included in the restoration processes?
- Has the problem that requires treatment been investigated and defined?
- Has consensus been reached on the mission of the restoration initiative?
- Have restoration goals and objectives been identified by all participants in the restoration effort?
- Has the restoration been planned with adequate scope and expertise?
- Has the restoration plan had an annual or midcourse correction point in line with adaptive management procedures?
- Have the indicators of stream corridor structure and function been directly and appropriately linked to the restoration objectives?
- Have adequate monitoring, surveillance, management, and maintenance programs been specified as an integral part of the restoration plan? Have monitoring costs and operational details been integrated so that results will be available to serve as input in improving techniques used in the restoration work?
- Has an appropriate reference system (or systems) been selected from which to extract target values of performance indicators for comparison in conducting the evaluation of the restoration initiative?
- Have sufficient baseline data been collected over a suitable period of time on the stream corridor and associated ecosystems to facilitate before-and-after treatment comparisons?
- Have critical restoration procedures been tested on a small experimental scale to minimize the risks of failure?
- Has the length of a monitoring program been established that is sufficiently long to determine whether the restoration work is effective?
- Have risk and uncertainty been adequately considered in planning?
- Have alternative designs been formulated?
- Have cost-effectiveness and incremental cost of alternatives been evaluated?

During Project Implementation and Management...

- Based on the monitoring result, are the anticipated intermediate objectives being achieved? If not, are appropriate steps being taken to correct the problem(s)?
- Do the objectives or performance indicators need to be modified? If so, what changes might be required in the monitoring program?
- Is the monitoring program adequate?

During Postrestoration...

- To what extent were restoration plan objectives achieved?
- How similar in structure and function is the restored corridor ecosystem to the reference ecosystem?
- To what extent is the restored corridor self-sustaining (or will be), and what are the maintenance requirements?
- If all stream corridor structure and functions were not restored, have the critical structure and functions been restored?
- How long did the restoration initiative take?
- What lessons have been learned from this effort?
- Have those lessons been shared with interested parties to maximize the potential for technology transfer?
- What was the final cost, in net present value terms, of the restoration work?
- What were the ecological, economic, and social benefits realized by the restoration initiative?
- How cost-effective was the restoration initiative?
- Would another approach to restoration have produced desirable results at lower cost?

4.B Problem and Opportunity Identification

Development of stream corridor restoration objectives is preceded by an analysis of resource conditions in the corridor. It is also preceded by the formulation of a problem/opportunity statement that identifies conditions to be improved through and benefit from restoration activities. Although problem/opportunity identification can be very difficult, in terms of measurable stream corridor conditions, it is the single most important step in the development of the restoration plan and in the restoration process. This section focuses on the six steps of the problem/opportunity identification process that are critical to any stream corridor restoration initiative.

Data Collection and Analysis

Data collection and analysis are important to all aspects of decision making and are conducted throughout the duration of the restoration process. The same data and analytic techniques

are often applied to, and are important components of, problem/opportunity identification; goal formulation; alternative selection; and design, implementation, and monitoring. Data collection and analysis, however, begin with problem/opportunity identification. They are integral to defining existing stream corridor and reference conditions, identifying causes of impairment, and developing problem/opportunity statements. Data collection and analysis should be viewed as the first step in this process.

Data Collection

Data collection should begin with a technical team, in consultation with the advisory group and the decision maker, identifying potential data needs based on technical and institutional requirements. The perspective of the public should then be solicited from participants or through public input forums. Data targeted for collection should generally provide information

The Six Steps of the Problem/Opportunity Identification Process

1. Data collection and analysis
2. Definition of existing stream corridor conditions (structure and function) and causes of disturbance
3. Comparison of existing conditions to desired conditions or a reference condition
4. Analysis of the causes (disturbances) of altered or impaired stream corridor conditions
5. Determination of how management practices might be affecting stream corridor structure and functions
6. Development of problem and opportunity statements

on both the historical and baseline conditions of stream corridor structure and functions, as well as the social, cultural, and economic conditions of the corridor and the larger watershed.

Data are collected with the help of a variety of techniques, including remote sensing, historical maps and photographs, and actual resource inventory using standardized on-site field techniques, evaluation models, and other recognized and widely accepted methodologies. *Community mapping* (drawing areas of importance to the community or individuals) is becoming a popular method of involving the public and children in restoration initiatives. This technique can solicit information not accessible to traditional survey or data collection techniques and it also makes the data collection process accessible to the public. Additional data collection and analysis methods are discussed in Part III, Chapter 7.

Collecting Baseline Data

Restoration work should not be attempted without having knowledge of existing stream corridor conditions. In fact, it is impossible to determine goals and objectives without this basic information. As a result, it is important to collect and analyze information that provides an accurate account of existing conditions. Due to the dynamic nature of hydrologic systems, a range of conditions need to be monitored. Ultimately, these *baseline data* will provide a point from which to compare and measure future changes.

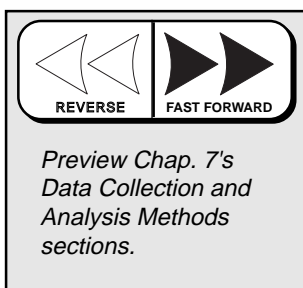
Baseline data consist of the existing structure and functions of the stream corridor and surrounding ecosystems across scales, as well as the associated

disturbance factors. These data, when compared to a desired reference condition (derived from either existing conditions elsewhere in the corridor or historical conditions), are important in determining cumulative effects on the stream corridor's structure and functions (i.e., hydrologic, geomorphic, habitat, etc.). Baseline data collection efforts should include information needed to determine associated problems and opportunities to be addressed in later design and implementation stages of the restoration process.

Collecting Historical Data

As described in earlier chapters, stream corridors change over time in response to ongoing natural or human-induced processes and disturbances. It is important to identify historical conditions and activities to understand the present stream corridor condition (**Figure 4.8**). Part of collecting *historical data* is collecting background information on the requirements of the species and ecosystems of concern. Historical data should also include processes that occurred at the site. The historic description may also be used to establish target conditions, or the reference condition, for restoration. Often the goal of restoration will not be to return a corridor to a pristine, or pre-European settlement, condition. However, by understanding this condition, valuable knowledge is gained for making decisions on restoring and sustaining a state of dynamic equilibrium.

In terms of gathering historical data, emphasis should be placed on understanding changes in land use, channel planform, cover type, and other physi-



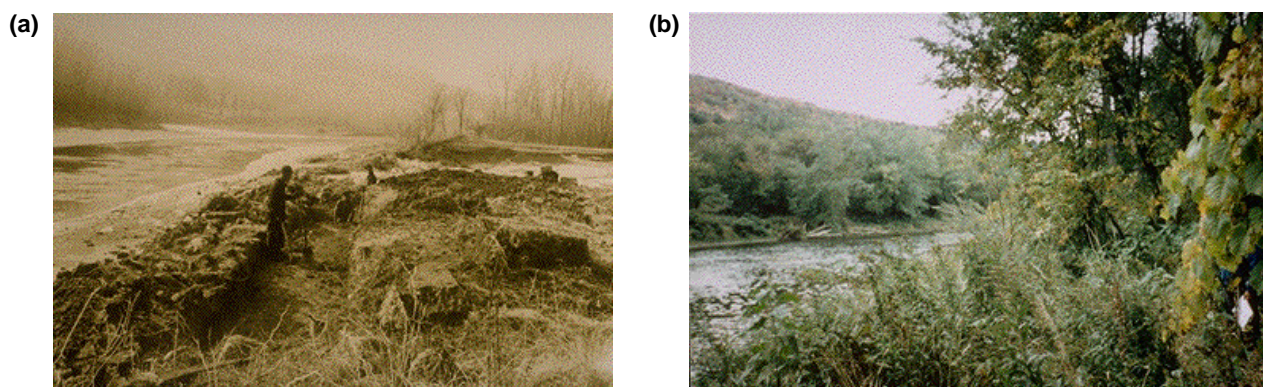


Figure 4.8: The Winooski River (a) in the 1930s and (b) at the same location in the 1990s.

Using photographs is one way to identify the historical condition of the corridor.

cal conditions. Historical data, such as maps and photographs, should be reviewed and long-time residents interviewed to determine changes to the stream corridor and associated ecosystems. Major human-induced or natural disturbances, such as land clearing, floods, fires, and channelization, should also be considered. These data will be critical in understanding present conditions, identifying a reference condition, and determining future trends.

Collecting Social, Cultural, and Economic Data

In addition to physical, chemical, and biological data, it is also important to gather data on the social, cultural, and economic conditions in the area. These data more often than not will drive the overall restoration effort, delimit its scale, determine its citizen and landowner acceptance, determine ability to coordinate and communicate, and generally decide overall stability and capability to maintain and manage. In addition, these data are likely to be of most interest to participants and should be collected with their assistance to avoid derailment or alteration of the restoration effort due to misconceptions and misinformation.

Properly designed surveys of social attitudes, values, and perceptions can also be valuable tools both to assess the changes needed to accomplish the restoration goals and to determine changes in these intangible values over time, throughout the planning process, and after implementation.

Prioritizing Data Collection

Although data on both the historical and baseline conditions related to ecosystem structure and functions and social, cultural, and economic values are important, it is not always practical to collect all of the available information. Budgets and technical limitations often place constraints on the amount and types of data that can be collected. It is therefore important for the technical team, advisory group, and decision maker to prioritize the data needed.

At a minimum, the data necessary to explain the mechanisms or processes that affect stream corridor conditions need to be collected. To illustrate the challenges of data prioritization, consider the example of identifying data for assessing habitat functions. Potential habitat data could include items such as the extent of impacted fish, wildlife, and other biota; ecological aspects; biological characteristics of soils and water; vegetation (both



Figure 4.9:
**Characterizing stream
corridor conditions.**

*Data collection and
analysis are important
components of problem
identification.*

native and nonnative); and relationships among ecological considerations (Figure 4.9). Depending on the scope of the restoration plan, however, data for all of these elements might not be necessary to successfully accomplish restoration. This holds especially true for smaller restoration efforts in limited stream reaches.

An effective way to prioritize data collection is through a scoping process designed to determine those data which are critical to decision making. The scoping process identifies significant concerns by institutional recognition (laws, policies, rules, and regulations), public recognition (public concern and local perceptions), or technical recognition (standards, criteria, and procedures).

Data Analysis

Data analysis, like data collection, plays an important role in all elements of problem identification as well as other aspects of the restoration process. Data analysis techniques range from qualitative evaluations using professional judgment to elaborate

computer models.

The scope and complexity of the restoration effort, along with the budget, will influence the type of analytical techniques selected. A wealth of techniques are discussed in the literature and various manuals and will not be listed in this document. Part I, however, provides examples of the types of processes and functions that need to be analyzed. In addition, Part III discusses some analytical techniques used for condition analysis and restoration design, offers some analytic methodologies, and provides additional references.

Existing Stream Corridor Structure, Functions, and Disturbances

The second step in problem identification and analysis is determining which stream corridor conditions best characterize the existing situation. Corridor structure, functions, and associated disturbances used to describe the existing condition of the stream corridor will be determined on a case-by-case basis. Just as human health is indexed by such parameters as blood pressure and body temperature, the condition of a stream corridor must be indexed by an appropriate suite of measurable attributes.

There are no hard-and-fast rules about which attributes are most useful in characterizing the condition of stream corridor structure and functions. However, as a starting point, consideration should be given to describing present conditions associated with the following eight components of the corridor:

- Hydrology
- Erosion and sediment yield
- Floodplain/riparian vegetation
- Channel processes
- Connectivity
- Water quality
- Aquatic and riparian species and critical habitats
- Corridor dimension

Since the ultimate goal is to establish restoration objectives in terms of the structure and functions of the stream corridor, it is useful to characterize those attributes which either measure or index the eventual attainment of the desired ecological condition. Some measurable attributes that might be useful for describing the above components of a stream corridor are listed in the box *Measurable Attributes for Describing Conditions in the Stream Corridor*. Detailed guidance for quantifying many of the following attributes is either described or referenced elsewhere in this document.

Existing vs. Desired Structure and Functions: The Reference Condition

The third step in problem identification and analysis is to define the conditions within which the stream corridor problems and opportunities will be defined and restoration objectives established. It is helpful to describe how the present baseline conditions of the stream corridor compare to a *reference condition* that represents, as closely as possible, the desired outcome of restoration (**Figure 4.10**). The reference condition might be similar to what the stream corridor



would have been like had it remained relatively stable. It might represent a condition less ideal than the pristine, but substantially improved from the present condition. Developing a set of reference conditions might not be an easy task, but it is essential to conducting a good problem/opportunity analysis.

Several information sources can be very helpful in defining the reference condition. Published literature might provide information for developing reference conditions. Hydrologic data can often be used to describe natural flow and sediment regimes, and regional hydraulic geometry relations may define reference conditions for channel dimensions, pattern, and profile. Published soil surveys contain soil map-unit descriptions and interpretations reflecting long-term ecological conditions that may be suitable for reference. Species lists of plants and animals (both historical and present) and literature on species habitat needs provide information on distribution of organisms, both by habitat characteristics and by geographic range.

Figure 4.10: Example reference condition in the western United States.

A reference condition may be similar to what the corridor would have been like in a state of relative "dynamic equilibrium."

Measurable Attributes for Describing Conditions in the Stream Corridor

Hydrology

- total (annual) discharge
- seasonal (monthly) discharge
- peak flows
- minimum flows
- annual flow durations
- rainfall records
- size and shape of the watershed

Erosion and Sediment Yield

- watershed cover and soil health
- dominant erosion processes
- rates of surface erosion and mass wasting
- sediment delivery ratios
- channel erosion processes and rates
- sediment transport functions

Floodplain/Riparian Vegetation

- community type
- type distribution

- surface cover

- canopy
- community dynamics and succession
- recruitment/reproduction

Channel Processes

- flow characteristics
- channel dimensions, shape, profile, and pattern
- substrate composition
- floodplain connectivity
- evidence of entrenchment and/or deposition
- lateral (bank) erosion
- floodplain scour
- channel avulsions/realignments
- meander and braiding processes
- depositional features
- scour-fill processes
- sediment transport class (suspended, bedload)

Connectivity

Water Quality

- color
- temperature, dissolved oxygen (BOD, COD, and TOC)
- suspended sediment
- present chemical condition
- present macroinvertebrate condition

Aquatic and Riparian Species and Critical Habitats

- aquatic species of concern and associated habitats
- riparian species of concern and associated habitats
- native vs. introduced species
- threatened or endangered species
- benthic, macroinvertebrate, or vertebrate indicator species

Corridor Dimension

- plan view maps
- topographic maps
- width
- linearity, etc.

In most cases, however, reference conditions are developed by comparison with *reference reaches* or sites believed to be indicative of the natural potential of the stream corridor. The *reference site* might be the predisturbance condition of the stream to be restored, where such conditions are established by examining relic areas (enclosures, preserves), historical photos, survey notes, and/or other descriptive accounts. Similarly, reference conditions may be developed from nearby stream corridors in similar physiographic settings if those streams are minimally impacted by

natural and human-caused disturbances.

Causes of Altered or Impaired Conditions

Conditions that provide the impetus for stream corridor restoration activities include degraded stream channel conditions and degraded habitat. A thorough analysis of the cause or causes of these alterations or impairments is fundamental to identifying management opportunities and constraints and to defining realistic and attainable restoration objectives.

The Condition Continuum

One helpful way to conceptualize the relationship between the current and reference conditions is to think of stream corridor conditions as occurring on a “condition continuum.” At one end of this continuum, conditions may be categorized as being natural, pristine, or unimpaired by human activities. A headwater wilderness stream could exist near this end of the continuum (**Figure 4.11**). At the other end of the continuum, stream corridor conditions may be considered severely altered or impaired. Streams at this end of the continuum could be totally “trashed” streams or completely channelized water conduits.

In concept, present conditions in the stream corridor exist somewhere along this condition continuum. The condition objective for stream restoration from an ecological perspective should be as close to the dynamic equilibrium as possible. It should be noted, however, that once other important considerations, such as political, economic, and social values, are introduced during the establishment of restoration goals and objectives, the target may shift to restoring the stream to some condition that lies between the present situation and dynamic equilibrium.

The proper functioning condition (PFC) concept is used as a minimum target in western riparian areas and can be the basis on which to plan additional enhancements (Pritchard et al. 1993, rev. 1995).

(a)



(b)



Source: L. Goldman

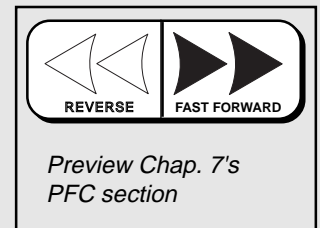


Figure 4.11: Condition continuum.

The condition continuum runs from (a) untouched by humans to (b) severely impaired.

Common Impaired or Degraded Stream Corridor Conditions

The following list provides some examples of impaired stream corridor conditions. A more complete list of these effects is provided in Chapter 3.

- Stream aggradation - filling (rise in bed elevation over time)
- Stream degradation - incision (drop in bed elevation over time)
- Streambank erosion
- Impaired aquatic habitat
- Impaired riparian habitat
- Impaired terrestrial habitat
- Loss of gene pool of native species
- Increased peak flood elevation
- Increased bank failure
- Lower water table levels
- Increase of fine sediment in the corridor
- Decrease of species diversity
- Impaired water quality
- Altered hydrology

As discussed in Chapter 3, for every stream corridor structural attribute and function that is altered or impaired, there may be a causal chain of events responsible for the impairment. As a result, when conducting a problem analysis, it is useful to consider factors that affect stream corridor ecological condition at different levels or scales:

- Landscape
- Stream corridor and reach

Landscape Factors Affecting Stream Corridor Condition

When analyzing landscape-scale factors that contribute to existing stream corridor conditions, disturbances that result in changes in water and sediment delivery to the stream and in sources of contamination should be considered. In alluvial stream corridors, for example, anything that changes the historical balance between delivery of sediment to the channel and sediment-transport capacity of the

Accelerated Bank Erosion: The Importance of Understanding a Causal Chain of Events

To illustrate the concept of a causal chain of events, consider the problem of accelerated bank erosion (**Figure 4.12**). Often the cause of accelerated bank erosion might be attributed to increases in peak runoff or sediment delivery to a stream when a surrounding watershed is undergoing land use changes; to the loss of bank vegetation, which also increases the vulnerability of the bank to erosion; or to structures in the stream (e.g., bridge abutments) that redirect the water flow into the bank. In this case, determining that bank erosion has increased relative to some reference rate is central to the identification of an impaired condition. In addition, understanding the cause or causes of the increased erosion is a key step in effective problem analysis. It is critical to the solution of the problem that this understanding be factored into the development of restoration objectives and management alternatives.



Figure 4.12: Bank erosion.
The cause(s) of bank erosion should be identified.

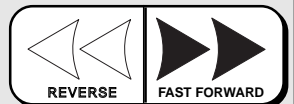
stream will elicit a change in channel conditions. When sediment deliveries increase relative to sediment-transport capacities, stream aggradation usually occurs; when sediment-transport capacities increase relative to sediment delivery, stream incision usually occurs. How the channel responds to changes in flow and sediment regime depends on the magnitude of change in runoff and sediment and the type of sediment load being transported by the stream—suspended sediment or bedload.

The analysis of watershed effects on channels is aided by the use of standard hydrologic, hydraulic, and sediment transport tools. Depending on the available data, results may range from highly precise to quantitative. Altered flow regimes, for example, might be readily discernible if the stream has a long-term gauge record. Otherwise, numerical runoff modeling techniques might be needed to place an approximate magnitude on the change in peak flows resulting from a change in land use conditions. Water developments such as storage reser-

voirs and diversions also must be factored into an analysis of altered watershed hydrology (**Figure 4.13**).

The effects of altered land use on sediment delivery to streams may be assessed using various analytical and empirical tools. These are discussed in Chapters 7 and 8. However, these tools should be used with some caution unless they have been verified and calibrated with actual instream sediment sampling data or measured reservoir sedimentation rates.

The stream channel itself might provide some clues as to whether it is experiencing an increase or decrease in sediment delivery from the watershed relative to sediment-transport capacity. Special attention should be paid to channel capacities and depositional features such as sand or gravel bars. If flooding seems to be more frequent, it might be an indication that aggradation is occurring. Conversely, if there is evidence of channel entrenchment, such as exposed bridge pier or abutment footings, degradation is occurring. Similarly, if the number and size of gravel bars are signifi-



*Preview Chap. 7 & 8's
Analytical and
empirical tools
section.*



Figure 4.13: Water releases below a dam.
Altering the flow regime of Glen Canyon Dam altered the stream condition.



Figure 4.14: Residential development.
Urbanization can severely impair conditions critical for riparian vegetation by increasing impervious surfaces.

cantly different from what is evident in historical photos, for example, the difference might be an indication that either aggradation or erosion has been enhanced. Care is needed when using the channel to interpret possible changes in watershed conditions since similar channel symptoms can also be caused by changes in conditions within the stream corridor itself or by natural variation of the hydrograph.

Stream Corridor and Reach Factors Affecting Stream Corridor Conditions

In addition to watershed factors affecting stream corridor conditions, it is important to consider disturbances at the stream corridor and reach scales. In general, stream corridor structural attributes and functions are greatly affected by several important categories of activities if they occur within the corridor. Chapter 3 explores these in more detail; the following are some of the activities that commonly impact corridor structure and function.

- Activities that alter or remove streambank and riparian vegetation (e.g., grazing, agriculture, logging, and urbanization), resulting in changes in the stability of streambanks, runoff and transport of contaminants, water quality, or habitat characteristics of riparian zones (**Figure 4.14**).
- Activities that physically alter the morphology of channels,

Localized Impacts Affecting the Stream Corridor

Spatial considerations in stream corridor restoration are usually discussed at the landscape, corridor, and stream scales (e.g., connections to other systems, minimum widths, or maximum edge concerns). However, the critical failures in corridor systems can often occur at the reach scale, where a single break in continuity or other weakness can have a domino effect on the entire corridor. Just as uncontrolled watershed degradation can doom stream corridor restoration effectiveness, so can specific sites where critical problems exist that can prevent the whole corridor from functioning effectively.

Examples of weaknesses or problems at the reach scale that might affect the whole corridor are wide-ranging. Barriers to fish passage, lack of appropriate shade and resultant loss of water temperature moderation, breaks in terrestrial migration lands, or narrow points that make some animals particularly vulnerable to predators can often alter conditions elsewhere in the corridor. In addition, other sites might be direct or indirect source areas for problems, such as headcuts or rapidly eroding banks that contribute excessive sediment to the stream and instability to the system, or locations with populations of noxious exotic plant species that can spread to other parts of the corridor system. Some site-specific land use problems can also have critical impacts on corridor integrity, including chronic damage from grazing livestock, irrigation water returns, and uncontrolled storm water outflows.

banks, and riparian zones, resulting in effects such as the displacement of aquatic and riparian habitat and the disruption of the flow of energy and materials (e.g., channelization, levee construction, gravel mining, and access trails).

- Instream modifications that alter channel shape and dimensions, flow hydraulics, sediment-transport characteristics, aquatic habitat, and water quality (e.g., dams and grade stabilization measures, bank riprap, logs, bridge piers, and habitat “enhancement” measures) (**Figure 4.15**). In the case of logs, it might be the loss of such structures rather than their addition that alters flow hydraulics and channel structure.

Altered riparian vegetation and physical modification of channels and floodplains are primary causes of impaired stream corridor structure and functions because their effects are both profound and direct. Addressing the causes of these changes might offer the best, most feasible opportunities for restoring stream corridors. However, the altered vegetation and physical modifications also may create some of the most significant challenges for stream corridor restoration by constraining the number or type of possible solutions.

It is important to remember that there are no simple analytical methods available for analyzing relationships between activities or events potentially disturbing the stream corridor and the structure and functions defining the



corridor. However, there are modes by which stream corridor activities and structures can affect ecological conditions that involve both direct and indirect impacts. The box *Examples of How Activities Occurring Within the Corridor Can Affect Structure and Functions* provides some examples of the modes by which activities can affect stream corridor structure and functions.

Figure 4.15: An abandoned dam.
Instream modifications such as a dam can disturb the corridor by altering flow and restricting migration.

Examples of How Activities Occurring Within the Corridor Can Affect Structure and Functions

- Direct disturbance or displacement of aquatic and/or riparian species or habitats
- Indirect disturbance associated with altered stream hydraulics and sediment-transport capacity
- Indirect disturbance associated with altered channel and riparian zone sedimentation dynamics
- Indirect disturbance associated with altered surface water-ground water exchanges
- Indirect disturbance associated with chemical discharges and altered water quality

In conducting the problem analysis, it is important to investigate the various modes of ecological interaction at the reach and system scales. The analysis might need to be subjective and deductive, in which case use of an interdisciplinary team is essential. In other cases, the analysis might be enhanced by application of available hydrologic, hydraulic, sedimentation, water quality, or habitat models.

Whatever the situation, it is likely that the analysis will require site-specific application of ecological principles aided by a few quantitative tools. It will rarely be possible to determine causative factors for resource impairment using uninterpreted results from off-the-shelf analytical models.

Part III, Chapter 7, contains a detailed discussion of some of the quantitative tools available to assist in the analysis of the resource conditions within the stream corridor ecosystem.

Determination of Management Influence on Stream Corridor Conditions

Once the conditions have been identified and the causes of those conditions described, the key remaining question is whether the causative factors are a function of and responsive to management. Specific management factors that contribute to impairment might or might not have been identified with the causes of impairment previously identified.

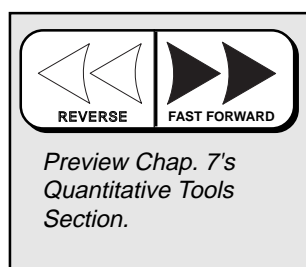
To illustrate, consider again the example of increased bank erosion. An initial analysis of impaired conditions might identify causes such as land uses in the watershed that are yielding higher flows and sediment

loads, loss of streambank vegetation, or redirection of flow from instream modifications. None of these, however, identify the role of management influences. For example, if higher water and sediment yields are a function of improper grazing management, the problem might be mitigated simply by altering grazing practices.

The ability to identify management influences becomes critical when identifying alternatives for restoration. Description of past management influences may prevent the repetition of previous mistakes and should facilitate prediction of future system response for evaluating alternatives. Recognition of management influences also is important for predicting the effectiveness of mitigation and the feasibility of specific treatments. Identifying the role of management is a key consideration when evaluating the ability of the stream corridor to heal itself (e.g., without management, with management, with management plus additional treatments). The identification of past management, both in the watershed and in the stream corridor, and its influence on those factors causing impairment will therefore help to sharpen the focus of the restoration effort.

Problem or Opportunity Statements for Stream Corridor Restoration

The final step in the process of problem/opportunity identification and analysis is development of concise statements to drive the restoration effort. *Problem/opportunity statements* not only serve as a general focus for the restoration effort but also become



Bluewater Creek

The watershed analysis and subsequent treatments performed at Bluewater Creek, New Mexico, demonstrate successful watershed and stream corridor restoration. Although most of the work has taken place on federal land, the intermixing of private lands and the values and needs of the varied publics concerned with the watershed make it a valuable case study. The project, begun in 1984, has a record of progress and improved land management. The watershed received the 1997 Chief's Stewardship Award from the Chief of the Forest Service and continues to host numerous studies and research projects.

Located in the Zuni mountains of north-central New Mexico, Bluewater Creek drains a 52,042-acre watershed that enters Bluewater Lake, a 2,350-acre reservoir in the East Rio San Jose watershed. Bluewater Creek and Lake provide the only opportunity to fish for trout and other coldwater species and offer a unique opportunity for water-based recreation in an otherwise arid part of New Mexico.

The watershed has a lengthy history of complex land uses. Between 1890 and 1940, extensive logging using narrow-gauge railroad technology cut over much of the watershed. Extensive grazing of livestock, uncontrolled fires, and some mining activity also occurred. Following logging by private enterprises, large portions of the watershed were sold to the USDA Forest Service in the early 1940s. Grazing, some logging, extensive roading, and increased recreational use continued in the watershed. The Mt. Taylor Ranger District of the Cibola National Forest now manages 86 percent of the watershed, with significant private holdings (12.5 percent) and limited parcels owned by the state of New Mexico and Native Americans.

In the early 1980s, local citizens worked with the Soil Conservation Service (now Natural Resources Conservation Service) to begin a Resource Conservation and Development (RC&D) project to protect water quality in the stream and lake as well as limit lake sedimentation harming irrigation and recreation opportunities. Although the RC&D project did not develop, the Forest Service, as the major land manager in the watershed, conducted a thorough analysis on the lands it managed and implemented a restoration initiative and monitoring that continue to this day.

The effort has been based on five goals: (1) reduce flood peaks and prolong baseflows, (2) reduce soil loss and resultant downstream channel and lake sedimentation, (3) increase fish and wildlife productivity, (4) improve timber and range productivity, and (5) demonstrate proper watershed analysis and treatment methods. Also important is close adherence to a variety of legal requirements to preserve the environmental and cultural values of the watershed, particularly addressing the needs of threatened, endangered, and sensitive plant and animal species; preserving the rich cultural history of the area; and complying with requirements of the Clean Water Act.

For analysis purposes, the watershed was divided into 13 subwatersheds and further stratified based on vegetation, geology, and slope. Analysis of data gathered measuring ground cover transects and channel analysis from August 1984 through July 1985 resulted in eight major conclusions: (1) areas forested with

Figure 4.17: Vehicle traffic through wet meadow in Bluewater Creek, NM. (May 1984.)

Such traffic compacts and damages soil, changes flow patterns, and induces gully erosion.



Figure 4.18: Recently installed treatment. (April 1987.)

Porous fence revetment designed to reduce bank failure.



Figure 4.19: Porous fence revetment aided by bank sloping. (August 1987.)

The photo shows initial revegetation during first growing season following treatment installation.



mixed conifer and ponderosa pine species were generally able to handle rainfall and snowmelt runoff; (2) excessive peak flows, as well as normal flows continually undercut steep channel banks, causing large volumes of bank material to enter the stream and lake system; (3) most perennial and intermittent channels were lacking the riparian vegetation they needed to maintain streambank integrity; (4) most watersheds had an excessive number of roads (**Figure 4.17**); (5) trails caused by livestock, particularly cattle, concentrate runoff into small streams and erodible areas; (6) several key watersheds suffered from livestock overuse and improper grazing management systems; (7) some instances of timber management practices were exacerbating watershed problems; and (8) excessive runoff in some subwatersheds continued to degrade the main channel.

Based on the conclusions of the analysis, a broad range of treatments were prescribed and implemented. Some were active (e.g., construction of particular works or projects); others were more passive (e.g., adjustments to grazing strategies). Channel treatments such as small dams, gully headcut control structures, grade control structures, porous fence revetments (**Figures 4.18, 4.19, and 4.20**), and channel crossings (**Figure 4.21**) were used to affect flow regimes, channel stability, and water quality.

Riparian plantings, riparian pastures, and beaver management programs were also established, and meander reestablishment and channel relocation were conducted. Land treatments, such as the establishment of best management practices (BMPs) for livestock, timber, roads, and fish and wildlife, were developed to prevent soil loss and maintain site productivity.

In a few cases, land and channel treatments were implemented simultaneously (e.g., livestock drift fences and seasonal area closures). Additional attention was paid to improved road management practices, and unnecessary roads were closed.

Results of the project have largely met its goals, and the watershed is more productive and enjoyable for a broad range of goods, services, and values. Although one weakness of the project was the lack of a carefully designed monitoring and evaluation plan, observers generally agree that the completed treatments continue to perform their designed function, while additional treatments add to the success of the project.

Most of the small in-channel structures are functioning as designed. The meander reestablishment has lengthened the channel and decreased gradient in a critical reach. The channel relocation project has just completed its first year, and initial results are promising. Beaver have established themselves along the main channel of Bluewater Creek, providing significant habitat for fish and wildlife, as their ponds capture sediment and moderate flood peaks. The watershed now provides a more varied and robust population of fish and wildlife species. Changes in road management have yielded significant results. Road closures have removed traffic from sensitive areas, and reconstruction of two key roads has reduced sediment damages to the stream. Special attention to road crossings of wet meadows has begun to rehabilitate scores of acres dewatered by improper crossings. Range management techniques (e.g., combined allotments, improved fencing, and more modern grazing strategies) are improving watershed condition. A limited timber management program on the federal property has had beneficial impacts on the watershed, but significant timber harvest on private lands provided a cause for concern, particularly regarding compliance with Clean Water Act best management practices.

The local citizens who use the watershed have benefited from the improved conditions. Recreation use continues to climb.

Figure 4.20: Porous fence revetments after two growing seasons. (September 1988.)

Vegetation is noticeably established over first growing season.



Figure 4.21: Multiple elevated culvert array at crossing of wet meadow. (June 1997.)

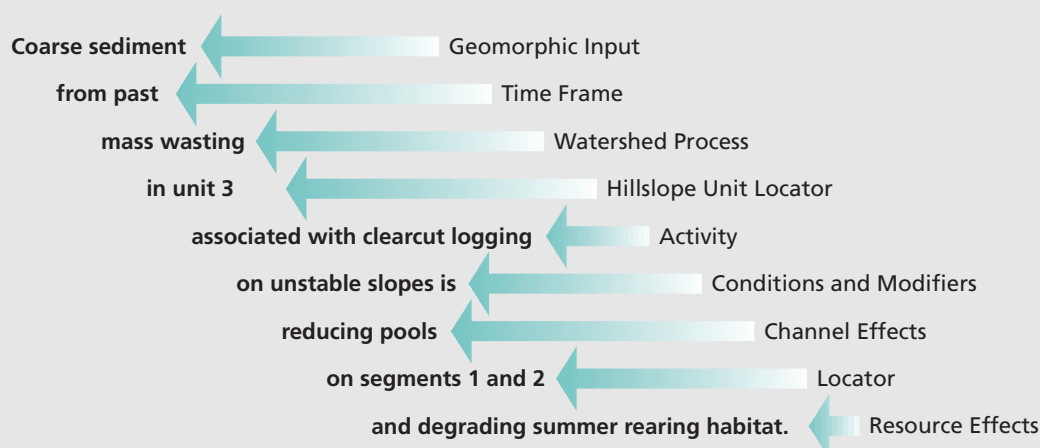
The culvert spreads flow and decreases erosion energy, captures sediment upstream, reduces flood peaks, and prolongs baseflows.



Problem/Opportunity Statements

Problem/Opportunity statements should follow directly from the analysis of existing and reference stream corridor conditions. These statements can be viewed as an articulation of some of the potential benefits that can be realized through restoration of the structure and functions of the stream corridor. For example, problem statements might focus on the impaired structural attributes and functions needing attention, while associated opportunities might focus on reintroduction of native species that were previously eliminated from the system. Problem/Opportunity statements can also focus on the economic benefits of a proposed restoration initiative. By identifying such economic benefits to local landowners, it may be possible to increase the number of private citizens participating in the planning process.

Example problem statement:



Example opportunity statements:

- To prevent streambank erosion and sediment damage and provide quality streamside vegetation through bioengineering techniques - Four Mile Run, Virginia.
- To protect approximately 750 linear feet of Sligo Creek through the construction of a parallel pipe system for storm water discharge control - Sligo Creek, Maryland.
- To enhance the creek through reconstruction of instream habitat (e.g., pools and riffles) - Pipers Creek, Washington.
- To reintroduce nongame fish and salamanders in conjunction with implementing several stream restoration techniques and eliminating point source discharges - Berkeley Campus Creek, California.

Example statements adapted from Center for Watershed Protection 1995.

the basis for developing specific restoration objectives. Moreover, they form the basis for determining success or failure of the restoration initiative. Problem/opportunity statements are therefore critical for design of a relevant monitoring approach. For maximum effectiveness, these statements should usually have the following two characteristics:

- They describe impaired stream corridor conditions that are explicitly stated in measurable units and can be related to specific processes within the stream corridor.
- They describe deviation from the desired reference condition (dynamic equilibrium) or proper functioning condition for each impaired condition.

